Boise Project, Boise River Diversion Dam
Boise River
Boise Vicinity
Ada County
Idaho

HAER No. ID-17-A

HAER
ID
1-BOISE.V,
1-A-

PHOTOGRAPHS

Historic American Engineering Record
Western Regional Office
National Park Service
U.S. Department of the Interior
600 Harrison Street, Suite 600

ADDENDUM TO: HAER ID-17-A
BOISE PROJECT, BOISE RIVER DIVERSION DAM *ID,1-BOISE.V,1-A-*
Across Boise River
Boise vicinity
Ada County
Idaho

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HAER
ID
1-BOISE.V
1-A-

HISTORIC AMERICAN ENGINEERING RECORD

BOISE PROJECT, BOISE DIVERSION DAM & POWERPLANT
ADDENDUM TO
BOISE PROJECT, BOISE RIVER DIVERSION DAM

HAER No. ID-17-A

Location: Boise River, 7 mi. southeast of Boise
Boise Vicinity
Ada County
Idaho

UTM: 11:573360:4820770 (Northeast point)
11:573280:4820680 (Southwest point)
Quad: Lucky Peak, Idaho, 1:24,000

Dates of Construction: 1906-1908, 1911-1912

Engineers: United States Reclamation Service

Present Owner: United State Bureau of Reclamation

Present Use: Diversion dam and powerplant

Significance: The Boise Diversion Dam and Powerplant are important components in the Boise Project, a Bureau of Reclamation effort to irrigate the Boise and Payette River valleys in Idaho. The diversion dam, completed in 1908, was one of the first Boise Project structures. It directs water into the New York Canal, which carries water throughout the Boise Valley. The powerplant, constructed in 1912, initially provided power to construct Arrowrock Dam, and retains much of its original hydroelectric equipment. The dam and powerplant are listed on the National Register of Historic Places for their contributions to the successful development of the Boise Valley and as an example of early twentieth-century hydroelectric engineering.

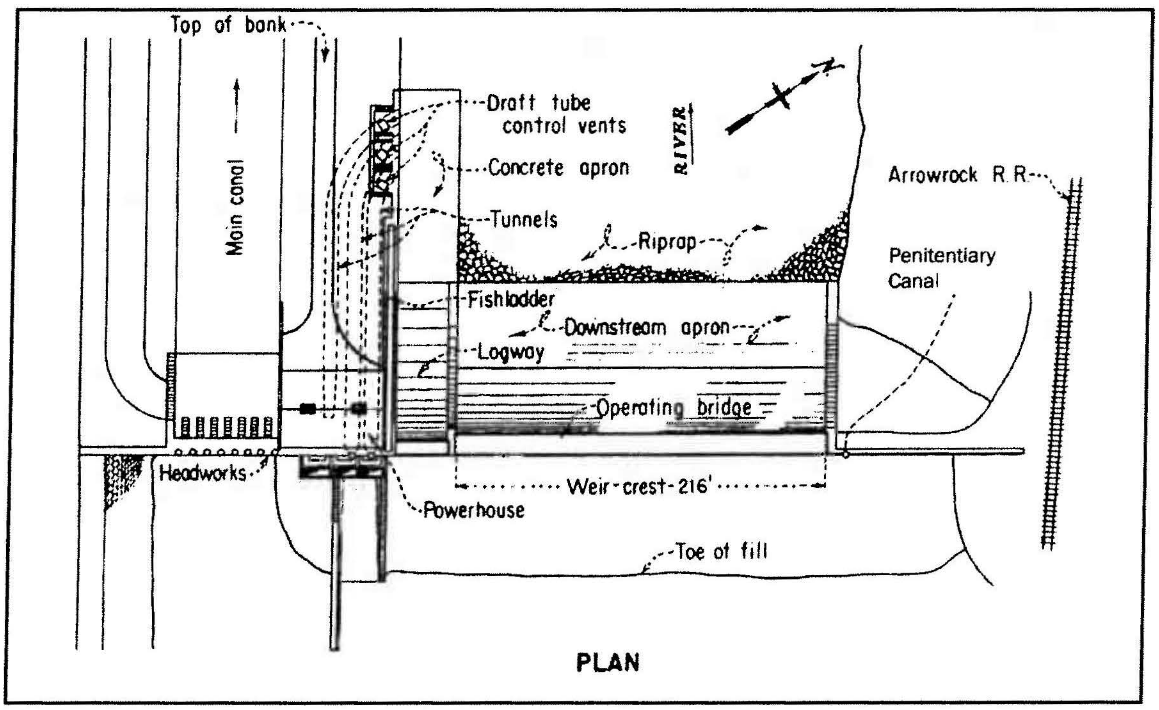
Project Information: The hydroelectric equipment at the Boise Diversion Dam Powerplant has been on reserve status since the early 1980s. The Bureau of Reclamation decided to rehabilitate the machinery and bring the plant online to reduce shortages in the western power supply. Because the diversion dam and powerplant are listed on the National Register of Historic Places, the Historic American Engineering Record documentation was undertaken to mitigate the effects of the rehabilitation. Hess, Roise and Company of Minneapolis, Minnesota, completed this report in 2006 under contract

with the Bureau of Reclamation. Historians Denis Gardner and Abigail Christman conducted research and fieldwork. Historian Elizabeth Gales also conducted research and drafted the report. Marjorie Pearson, Ph.D. provided project management and Charlene Roise served as Principal Investigator. Clayton B. Fraser of Fraserdesign in Loveland, Colorado, and Dave Walsh, of the Bureau of Reclamation's Snake River Area Office, provided large format photography. Dr. Ray Leicht, of the Bureau of Reclamation's Snake River Area Office, and Lynne MacDonald, of the Bureau of Reclamation's Pacific Northwest Regional Office, offered valuable assistance during the research phase of this project, as did Snake River Area Office engineer Karl Ames. Paul Deveau and Pat Smith at the Boise Project Control Board also contributed valuable information concerning the dam site.

Description

Site

The Boise Diversion Dam and Powerplant are located on the Boise River, a waterway that flows generally east to west. The site is approximately seven miles southeast of the city of Boise and fifteen miles southwest of Arrowrock Dam. State Highway 21, which follows the Boise River, provides access to the camp and dam from the north. The dam and New York Canal headgates were constructed in 1906-08 by the Utah Fireproofing Company as part of the Boise Project. The powerplant and existing government camp buildings were added in 1911-13. The site was chosen for its proximity to the New York Canal whose headgates now form the south end of the dam. The powerhouse, logway, and spillway crest are located north of the canal headgates. The headgate to the Penitentiary Canal is located at the dam's north end. The camp, comprising House No. 15, House No. 16, Building No. 203, and Building No. 205, is approximately a third of a mile downstream from the dam on the river's north bank. These buildings are grouped together on a terraced site protected by stone and riprap retaining walls.[1]



[1] This description is based on a site visit by Denis Gardner and Abigail Christman on October 30, 2001. Information in Charles H. Paul's "Boise Project Storage Unit Feature Report: The Boise Power Plant," May 1912, General Records, Washington, D. C., Entry 10, Box 48, Records of Bureau of Reclamation, Record Group 115, National Archives and Records Administration, Federal Records Center, Denver, Colorado, 2-3, also contained useful descriptive information. Hereafter, records from the Bureau of Reclamation, Record Group 115 will be indicated by the use of RG 115; records in the Denver Federal Records Center of the National Archives and Records Administration are indicated by the use of FRC Denver. See ID-17-A-76 for an overall plan of the site.

Boise Diversion Dam[2]

The Boise Diversion dam is a rubble-concrete weir structure that diverts water from the Boise River into the New York Canal. It is a gravity dam; its weight resists force from the water's pressure, weight, and uplift. Its foundation is built on a bed of compacted gravel below the riverbed at an elevation of 2761.84 feet. The dam is 100' wide at its foundation, narrowing to about 10' at its crest. A rock-and-gravel-filled timber apron stretches for 48' downstream at the dam's toe. The ogee-type, spillway crest has a hydraulic height of 35' and the downstream face of the spillway a slope of 0.75' to every 1'. The dam's maximum height is 68' including the concrete-pier bridge. The crest is approximately 220' long and the length of the dam from abutment to abutment is 500'. South of the spillway is the 30' wide logway. The 62' wide powerhouse and the 73' wide New York Canal headworks are south of the logway. Two sluice tunnels are located at an elevation of 2773.09 feet on the northeast corner of the powerhouse. These tunnels sluice water and silt through the dam and also serve as tailrace tunnels for two of the powerplant's generators. Two 6' x 8' sliding gates control water flow through the tunnels. Earth-filled abutments form the north and south ends of the dam. They are faced with concrete on the upstream side to prevent erosion.

During the irrigation season, wood flashboards can be placed in between the bridge's concrete piers to raise the level of the forebay pool behind the dam. This water is diverted into the New York Canal or allowed to pass over the spillway crest, depending on the area's irrigation needs. The forebay pool has had an average elevation of 2816.5 feet during the irrigation season. In the fall and winter months the forebay is drained with only a river channel leading to the sluice gate intake.[3]

The rubble-concrete logway is located immediately south of the spillway. It is 30' wide and originally had a crest elevation of 2808.84 feet, 4' below the spillway crest; the crest elevation was raised to 2810.57 in recent years. The logway has a gentler sloping downstream face than the spillway and extends further out into the river. The base of the dam is 100' wide at this section. A roller gate measuring 8' tall and 30' wide to control water flow was installed in 1913. Immediately south of the logway is a narrow opening that originally contained a terraced fish ladder. The timber framing composing the stepped levels of the ladder was removed in the 1970s due to rot and lack of use.

The headgates to the New York Canal, also called the Main South Side Canal, are positioned on the south abutment of the dam. These are formed of eight 5' x 9' motor-operated slide gates that control the flow of water into the canal. The gates are composed of cast-iron leaves, brass seats,

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[2] The current appearance of the dam is documented in photographs ID-17-A-1 through ID-17-A-5, ID-17-A-9 through ID-17-A-16, and ID-17-A-31 through ID-17-A-32. See ID-17-A-74 for a copy of the historic plan.

[3] Eric B. Kollgaard and Wallace L. Chadwick, eds., *Development of Dam Engineering in the United States* (New York: Pergamon Press, 1988), 13; Bureau of Reclamation, "Draft Environmental Assessment: Boise River Diversion Dam Powerplant Rehabilitation," available at the Bureau of Reclamation, Pacific Northwest Region, Snake River Area Office, Boise, December 2001, 7. See ID-17-A-75 for a drawing of the flashboards.

cast-iron guides, and steel rod stems. They are set in a 26' tall reinforced concrete wall originally built in 1908. Gate lifts to open and close the headworks are situated on top of the concrete wall. Another headgate is located on the upstream wall of the north abutment. It is a 3' square hand-operated slide gate that admits water into the Penitentiary Canal, also called the North Side Canal. The present gate was installed in 1970 and is composed of a fabricated steel leaf with a structural steel frame, steel guides, rod stem, stem guides, and gate lift. A handwheel, mounted on the retaining wall above the gate, controls its operation.

Powerplant Exterior[4]
Although the U. S. Reclamation Service (Bureau of Reclamation) recognized hydroelectric possibilities at the diversion dam site in 1905, a powerplant was not included in the final design for the dam.[5] A section of 6' thick wall with an elevation 17' above the spillway crest proved to be a suitable location for a powerhouse. The plant was designed and built to fit this space on the south end of the dam, between the New York Canal headgates and the logway. It is constructed of reinforced concrete and measures 62' x 44'. The structure rises 102', with 57' situated below the main level. The powerhouse has Classical Revival details on its symmetrical faces. Brackets on the north and south walls support modest pediments containing bulls-eye windows, which were replaced with ventilating fans and covered with metal sheathing.

All of the walls are divided into three horizontal sections by wide belt courses. The lower section of each side has a different treatment. The west wall is the most detailed containing a wood garage door in the southernmost bay, a wood door in the next bay, and two wood-frame six-over-six single-hung sash windows in the two north bays. The lower section of the south wall contains no openings since the New York Canal flows by that section of the powerhouse. The east side is dominated by a trashrack which screens the three 9' x 12' openings to the turbine wheel pits. The lower section of the north face holds the discharge opening to the surge tunnel.

Five pilasters divide the middle sections of the east and west faces into four bays. A wood-frame sixteen-over-sixteen single-hung sash window dominates each bay. Pilasters divide the middle sections of the north and south walls into three bays. The south wall's east bay contains a doorway to the main level. The other two bays contain identical windows to those on the east and west facades. The east bay of the north wall contains a wood-frame sixteen-over-eight window. This is to accommodate the operating mechanism for the logway's roller gate. The remaining bays contain sixteen-over-sixteen single-hung sash windows. Two wood-frame eight-light windows occupy the upper-section end bays of the north, south, and east faces.

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[4] The exterior of the powerplant is documented by photographs ID-17-A-1 though ID-17-A-6, ID-17-A-8 through ID-17-A-9, and ID-17-A-12 and ID-17-A-13. See ID-17-A-73 for an original drawing of the powerplant.
[5] U.S. Department of the Interior, *Fourth Annual Report of the Reclamation Service* (Washington, 1910), 352.

Powerplant Interior[6]

Lower Level—Upstream Side

Located on the upstream side of the powerhouse's lower level are three wheel pits, each measuring 14' x 16' with a depth of 37'. The pit floors are at an elevation of 2790.76 feet. Each pit holds a twin-wheel inward-flow center-discharge, or Francis, turbine mounted on a vertical shaft. When operative, the turbines have a normal effective head of 24' and speed of 180 revolutions per minute (rpm). Their maximum capacity is 850 horsepower (hp) but they have been tested up to 920 hp. Water is admitted to the wheel pits through three 9' x 12' openings in the upstream wall of the dam. Each opening is controlled by a butterfly gate, which pivots on a center axis to admit water into a reinforced-concrete draft tube that directs the water to the turbine. After passing through the turbine, the water continues out through the intake flume, which curves downward to empty the water into a tailrace tunnel. The two north tailrace tunnels are the original sluicing tunnels from 1908. The third tailrace tunnel was added parallel to the originals when the plant was built in 1910-12. Water speed is regulated by a 6' x 7' surge tunnel built perpendicularly across the ends of the intake flumes. Because the tunnel intersects with the beginnings of the tailraces, the exiting water is slowed before it re-enters the river thereby preventing cavitation at the outlet openings.[7]

Middle Level

The turbines are controlled by automatic oil-pressure governors, which are located on the main floor of the powerhouse. Each governor is driven by bevel gears and belts connected to the main turbine shaft. The governors operate on open tank systems without vacuum pressure. The thrust-bearing floor is located between the wheel pits and the main level at elevation 2818.84 feet. The floor supports all the revolving parts of the turbines and generators. All of the rotating weight rests on three thrust bearings. The bearings have cast-iron working parts set in an oil bath so that all surfaces are continuously lubricated. Each bearing can support up to 26,000 pounds of metal rotating at a speed of 180 rpm. The turbines, governors, and thrust bearings were manufactured by the Allis-Chalmers Company. Allis-Chalmers also provided the generators and exciters located in the main level of the powerhouse.[8]

Main Level

The main floor of the building houses most of the electrical-generation equipment. The three original Allis-Chalmers generators are of the vertical three-phase sixty-cycle revolving-field type. Each operates at a speed of 180 rpm and produces 2300 volts of electricity. Each generator has a normal rating of 500 kilowatts (kW), or 625 kilovolt-amperes (kv-a), at 80 percent power. They were often operated at a higher rating of 118 percent power. Each generator is directly connected to a turbine shaft by the exciter and a clamp coupling. The interpole exciters consist of

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[6] The interior of the powerplant is documented by ID-17-A-17 through ID-17-A-30 and ID-17-A-44 through ID-17-A-53. See ID-17-A-73 for original drawings of the powerplant.

[7] James M. Gaylord, "Power Development on the Boise Project," July 1, 1913, General Records, Washington, D.C., Entry 3, Box 389, File No. 11, RG 115, FRC Denver, 15-16.

[8] Gaylord, 16-20.

55 kW 125-volt compound-wound upper spiders connected to the turbine shafts by flange couplings. An exciter focuses the mechanical energy of the turbine shaft into the generator's core, which converts the mechanical energy to electric power. Each generator is synchronized at 2300 volts and connected to its own transformer.

The transformers are located on the main floor north of the switchboard. Unlike the generators, exciters, governors, and turbines, the three-phase air-blast transformers were supplied by the Westinghouse Electric and Manufacturing Company. Each unit has a voltage ratio of 2300 volts delta to 22,000 volts star, and a rated capacity of 625 kv-a. The transformers receive the 2300 volts delta from the generators and increase it to 22,000 volts star for transmission away from the plant.[9] The transformers are cooled by two 3-hp three-phase 220-volt induction-motor blowers. These produce 6,180 cubic feet of 77-degree-temperature air per minute. The 2300-volt side of each transformer is connected to the 2300-volt switchgear by conduits embedded in the concrete floor. The switchboard is divided into ten panels of 2" thick marine-finished slate supported by a pipe framework. The auxiliary transformer panel is the southernmost panel, on the left end of the switchboard. To its immediate right are three exciter control panels. The three feeder control panels are to the right of the exciter controls. The three panels on the right end of the switchboard regulate the generators. The equipment is arranged so the generators could be completely controlled from the switchboard. The exciter panels are equipped with double buses and all the direct-current circuits have double-through switches. Each feeder circuit is provided with a three-phase set of electrolytic lightning arresters mounted on the gallery above the switchboard.[10]

The gallery is located on the downstream side 17' above the main floor and can be reached by an iron ladder fixed to the wall in the northwest corner of the main level. It contains the high-tension wiring and switches and supports the lightning arresters. The original 15-ton traveling crane can be accessed from the gallery. The crane, consisting of a bridge (main beam) upon which the trolley traverses, spans 32' on the north end of the room and is operated by hand. It was an important tool in the powerhouse, and was used to hoist heavy machinery and parts. Original drawings for the crane indicate that it could support up to 30,000 pounds.

Lower Level—Downstream Side

When the building's foundation was excavated, a well was dug in the lower level on the downstream side of the plant. It provides clear water to submerge and lubricate the lignum vitae bearings of the generators and to cool the thrust-bearing coils. Water is pumped to a storage tank

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[9] The volts delta and star refer to two different transformer connections. The delta connection is used for lower voltages, while the star connection has a larger amount of copper but a smaller number of winding turns, making it stronger and capable of handling higher currents. It is a simple matter to step up the voltage by pairing the delta connection to the star connection; Lamar Lyndon, *Hydro-Electric Power,* vol. 2 (New York: McGraw-Hill Book Company, Inc., 1916), 44-48.

[10] Gaylord, 19-22; "Draft Environmental Assessment," 2; Charles H. Paul, "Boise Project Storage Unit, Feature Report: The Boise Power Plant," May 1912, General Records, Washington, D.C., Entry 10, Box 48, RG 115, FRC Denver, 6-7.

on the gallery through a 2" diameter vertical pipe by a centrifugal pump connected to a 5 hp induction motor. The water is then transported to the machinery through sight-feed faucets next to each generator. The remaining area in the powerhouse is occupied by a machine shop and storage area on the downstream side's lower level, which is at a higher elevation of 2815.84 feet than the turbine pits on the upstream side. The bases of the transformer poles can be accessed from the shop through doors in the south bays. A dirt road running along the top of the New York Canal's north bank is also reached through the machine shop.[11]

House No. 15

House No. 15 was built in 1913 to house the dam and powerplant's chief operator and his family. Of frame construction, the house had rough 12" sheathing and a shingled, pyramidal roof with a one to three pitch. Measuring 28' square, the building was composed of four rooms and one bathroom, all with 8'-3" ceilings. All walls and ceilings were plastered, and the house was "equipped with good plumbing, hot and cold water and electric lights." The house also had a concrete cellar and foundation.[12]

Presently the house is composed of the original pyramidal-roofed building with a gable-roofed addition on the west end. The roofline has been extended on the east and north sides to accommodate small shed additions, and the entire roof is clad in composite shingles. The exterior walls are finished in light-blue stucco. The west facade contains two aluminum-frame vertical-sash sliding windows, a contemporary wood door, and an aluminum-frame screen door. A gable-roofed overhang above the doorway and an attic vent is located in the peak of the gable. The south wall also has two aluminum-frame vertical-sash sliding windows and an additional aluminum-frame Chicago-type window. The electric meter is situated on this wall.

The east side has a shed addition located near the center point of the wall. This addition has one aluminum-frame one-over-one single-hung sash window on each east and south wall. These windows are set in openings finished with wood lintels, jambs, and sills. The upper half of the addition is clad in wood sheathing and the lower half in stucco. The original east wall of the house holds two aluminum-frame windows, one on each side of the addition. The window at the south is made up of a large fixed pane over a sliding vertical sash. The window at the north is also formed of a large fixed pane over three smaller panes, the middle one being operable by a crank mechanism. A stove or ventilation pipe projects from the slope of the east roof.

Another shed addition is situated on the east end of the north side. The addition's north wall includes a modern wood door, aluminum-frame screen door, and aluminum-frame vertical-sash sliding window. The west wall holds an identical window to that on the north wall. Like the addition on the east side, the upper halves of the walls are wood sheathing and the lower half stucco. The windows are also finished with wood lintels, jambs, and sills. The remainder of the

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[11] Gaylord, 17.
[12] Gaylord, 22-23. See ID-17-A-76 for the location of House No. 15 within the site.

north side has two aluminum-frame windows. The window at the east is a one-over-one single-hung sash set in a wood surround, and the window at the west is a sliding vertical sash.

Low brick planters are placed next to the house on the west, south, and east sides. A low retaining wall and sidewalk wrap around from the west entrance to the north entrance. An air-conditioning unit is set next to the shed addition on the east wall. Directly west of the house is the carport. It is formed of a shingled shed roof supported by six steel poles anchored in concrete. Low brick walls, like those used for the planters, link the poles. Green fiberglass corrugated sheathing has been affixed to the north side of the carport, screening the interior from inclement weather. A 3' high chain-link fence encloses the yard on the west end. A taller wire-mesh fence encloses the south and east sides of the yard. Stone- and concrete-retaining walls north and south of the house protect the property.

House No. 16
Like House No. 15, House No. 16 was built around 1913 to house staff. The building is located on the west edge of the camp. The one to three hipped roof was shingled and the exterior walls covered with 12" rough sheathing. The 8'-3" ceilings were plastered, as were all the interior walls. Three rooms, a bathroom, and a screen porch were compacted into the 26' x 18' building, which rests on a concrete foundation above a concrete basement.[13]

Presently the building has asbestos siding, which has been painted pink, and it has a roof of composite shingles. A concrete chimney and stovepipe project from the ridge of the roof. The north, or front, facade has a modern aluminum-and-glass door, with a screen door located at the west corner. A gabled-roof overhang shelters the entrance. The two wood-frame windows consist of a fixed single pane at the east and a two-over-two single-hung sash with a wood-frame screen at the west. Both windows are set in openings framed with wood lintels, jambs, and sills. A wood single-pane casement window is situated in the only opening on the west wall. It is set in a wood surround and has a wood-frame screen. The south, or rear, wall consists of a wood door and wood-frame screen door set off-center in the wall and flanked by two wood-frame two-over-two single-hung sash windows. A shed-roof overhang is positioned over the doorway and attached to the underside of the eave. Two 2" x 4" boards are braced between the overhang and the building's wall. Wood steps lead to the door. Like the west wall, the east wall has only one opening filled with two wood-frame one-over-one single-hung sash windows. The house is in poor condition and has not been lived in for several years.

Building No. 203
Building No. 203 is a steel-frame storage shed set on a concrete slab and formed of walls clad in wood sheathing. It has a gable roof covered with corrugated metal. There is one large door opening on the north facade. The sliding wood door has been painted gray to match the garage doors on Building No. 205. Electrical boxes are fixed to the northwest corner of the facade. A

[13] Gaylord, 22-23. See ID-17-A-76 for the location of House No. 16 within the site.

gooseneck lamp projects from the peak of the north wall. There are no other window or door openings on the building.

Building No. 205

Building No. 205 is located between the other two houses in the camp. It was originally built as a double cottage, called House No. 17, measuring 52' x 18'. Each half contained three rooms, a bath, and a closet. Porches were attached to the north and south sides. It was framed and finished with the same materials as the other two cottages.[14]

Currently the building is divided into a three-car garage and office. The exterior is clad in beige-painted asbestos shakes. The roof is finished with composite shingles, and gutters have been attached to the eaves. Three garage-door openings and gray-painted metal garage doors dominate the north wall. Two doors are located toward the east end of the wall. The westernmost door is wood with a four-pane window. The other door is a modern wood door with an aluminum-frame screen door. The wall's only window opening is located at the east corner and is filled with a wood-frame fixed-pane window. The west wall has no window or door openings. A shed-roofed addition is situated on the west end of the south side. There are no openings on the addition. The remainder of the south side includes two windows. The westernmost is a wood-frame two-over-two single-hung sash window, and the other is a small wood-frame fixed-pane window. One wood-frame one-over-one single-hung sash window with a wood-frame screen is located on the east wall. Plants and debris grow or lean against the building's side and rear walls.

[14] Gaylord, 22-23. See ID-17-A-76 for the location of Building No. 205 within the site.

History of Boise Diversion Dam and Powerplant

Introduction

The Boise Diversion Dam was completed in 1908 as part of the first phase of the Bureau of Reclamation's Boise Project. This project, consisting of the Arrowrock and Payette Divisions, stores water and distributes it for irrigation throughout the Boise and Payette Valleys. The dam diverts water from the Boise River into the New York Canal, which carries water to be distributed to the terraces south of the Boise River. The diversion dam's hydroelectric powerplant was built in 1911-12 to provide electricity for construction of Arrowrock Dam. Later the power was used to operate irrigation pumps and was sold to private power companies for domestic distribution. The dam and powerhouse have become integral to widespread irrigation in the Boise Valley.

Bringing Water to the Valley

Early irrigation attempts in Idaho were privately funded. Historically the first irrigation occurred in the 1840s at Fort Boise, the Hudson Bay Company's fur trading outpost at the convergence of the Boise and Snake Rivers. However, attempts at widespread irrigation did not occur until the 1860s. In 1862, the discovery of gold in the Boise River Valley attracted prospectors, and the population expanded to 20,000 in the following year. The town of Boise was established in 1864 with mining and agriculture as the region's income-producing industries. Three canal companies had been started to bring irrigation water to agricultural land, but only twenty-one miles of canals were developed. As the population continued to grow over the next fifty years, the number of companies would likewise increase.[15]

Early irrigation companies in the Boise Valley concentrated on the construction of sloughs and ditches to carry water from the Boise River to farms. William S. Morris was one early businessman who, in 1873, enlarged an existing log canal for agricultural use. His nephew took control after Morris's death, and the canal had some success as the Ridenbaugh Canal, one of the major waterways in the Boise Valley. Like other canals in the area the Ridenbaugh had frequent changes in ownership, beginning with Morris and his family and moving on to the Boise Land and Irrigation Company.[16] Another major canal in the area, the New York Canal, was begun by New Yorker John H. Burns in 1882. Burns planned two major waterways, one on the east end of the valley and the other on the west end. His project manager and chief engineer, A. D. Foote, formulated plans for a canal to irrigate 500,000 acres. However, the project hit several financial

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[15] Frederic L. Quivik and Amy Slaton, "Boise Project, Deer Flat Embankments," 1990, Historic American Engineering Record (HAER) Report No. ID-17-B, available at BOR Pacific Northwest Regional Office, Boise, 19-20; Denis Gardner, "Arrowrock Dam" (draft), 2002, HAER Report No. ID-27, available at BOR Pacific Northwest Regional Office, Boise, 13-15.

[16] The canal is presently owned by the Nampa and Meridian Irrigation District, which purchased the property from the Boise Land Irrigation Company.

and engineering snags along the way. Both the Ridenbaugh and the New York canals would become entrenched in land and water rights battles that would halt the projects in the 1890s. While both systems managed to serve the needs of their users, the canals were only stilted versions of original plans.[17]

The Homestead Act of 1862 and the Desert Land Act of 1877 attracted many more settlers to the area. Federal policy focused on private endeavors, which were successful in settling the midwestern region of the country but not the arid western lands. The problem was that of getting water to the land. Novice farmers could not survive without irrigation, but they did not have the finances or knowledge to excavate canals. The 1894 Carey Act granted one million acres to each arid western state. The states had to settle, irrigate, and cultivate the land in tracts no larger than 160 acres. Within ten years at least twenty acres of each tract had to be in cultivation. Like the acts before it, the Carey Act supported private enterprise. The states would contract the work on the canals out to private construction companies who would, in turn, build the systems. The firms would then sell the water to gain reimbursement. The act did not become successful until the twentieth century. People in the west refused to invest money in risky private enterprise. While irrigation canals were relatively simple to design and construct, the canal companies did not control the rivers. In the spring, rivers were overflowing with runoff from the mountains, but by the end of summer the river flow dwindled and so did irrigation. Dams and reservoirs were needed to control and store water that would make wet farming viable. Only the federal government had the capital and authority to develop the massive irrigation projects needed to transform the arid West into a "land where the sun shines and the flowers bloom," and "where delicious fruit gladdens the boughs."[18]

A Federal Partnership

In 1902, after decades of lobbying from western politicians and landowners, the Newlands Act, or Reclamation Act, was passed in Congress. The act created the United States Reclamation Service (Reclamation) under the auspices of the United States Geological Survey (USGS), part of the Department of the Interior. Reclamation was empowered to build dams, canals, laterals, and all other pertinences needed for workable irrigation systems. The act also specified that tracts of no more than 160 acres would be eligible for cultivation. Owners had to reside on the land and also pay for the cost of constructing irrigation projects, at no interest, over an extended period. When the projects were completely paid for, the operation and maintenance would be turned over to irrigation districts that represented the landowners. Because the act had been proposed in the 1900-01 fiscal year and passed in 1902, Reclamation had an established appropriation of $8 million. Immediately the western states and territories began jockeying for projects.[19]

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[17] Quivik and Slaton, 20-24; Gardner, 14-15.

[18] Michael C. Robinson, *Water for the West, The Bureau of Reclamation, 1902-1977* (Chicago: Public Works Historical Society, 1979), 5-9; Quote from *Boise, Idaho* (Boise: Boise Commercial Club, [1912]), n. p.

[19] Quivik and Slaton, 24-27; Gardner, 15-16.

Idaho received two of Reclamation's earliest projects, Minidoka and Payette-Boise. Impetus for these projects had been growing since the 1870s when USGS surveys highlighted potential irrigation sites. In 1878, John Wesley Powell conducted a survey of western lands and reported that acreage could be cultivated if sufficient means for irrigation were developed. Powell's survey was followed nine years later by a comprehensive study of the Boise and Payette Valleys by New York Canal engineer A. D. Foote. Foote compiled several years' worth of research on the flow of the Boise River, the effect of melted snow pack on the river, the types of crops grown, and the income earned from agriculture to support his theory that 350,000 acres of land were irrigable in the Payette and Boise Valleys. He rounded out the report with a proposal for a complex irrigation scheme of canals and reservoirs. This study served as the foundation for building the Payette-Boise Project; however, work on a valley-wide irrigation system did not become reality until the establishment of the United States Reclamation Service. Local irrigation companies constructed many canals and lateral ditches, but a series of dams was needed to store and divert water.[20]

In 1903, the state engineer, D. W. Ross, led a group of engineers around the Boise and Payette River watersheds, scouting for possible dam and reservoir sites. That same year Ross would resign his state position to take control of Department of the Interior's reclamation work in Idaho. In December, news leaked to the local press that Reclamation was considering developing a project in the Boise Valley. A series of pro-Reclamation meetings that lasted into the spring of 1904 were hosted by Ross; J. H. Lowell, the state irrigation commissioner; and Frank Steunenberg, a former governor, to drum up support for a project. The men were successful and in April sent a formal request from the Boise and Payette Valley landowners to the Secretary of the Interior for approval of an irrigation project in the area. Reclamation authorized Ross to take two survey teams into the Boise and Payette Valleys to collect data for project planning. In May, tentative plans, including the construction of a 10' high, 400' long diversion dam on the Boise River, were announced. Even though these plans would be extensively revised, they served to motivate public support for a Reclamation project. The Payette-Boise Water Users Association was incorporated in September 1904, with J. H. Lowell as president of the board of directors and Steuenberg as a member. Because of their efforts to organize support among landowners in southern Idaho, the Payette-Boise Project was shown to be a viable investment for the federal government.[21]

Although the groundwork was quickly laid for the Payette-Boise Project, a portion of the Minidoka Project was the first Reclamation work to be executed in Idaho. Minidoka, planned by the state under the Carey Act, had never been realized. The project was begun in 1905 with construction of Minidoka Dam. The 86' high structure was nearly 4,500' long as it spanned the Snake River near the intersection of the Minidoka, Cassia, and Blaine County lines.

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[20] Quivik and Slaton, 27-29; Gardner, 16-17; Neil H. Carlton, "A History of the Development of the Boise Irrigation Project" (master's thesis, Brigham Young University, 1969), 12.
[21] Quivik and Slaton, 27-29; Gardner, 16-17; Carlton, 38-39, 42-44, 45-48, 51-55.

Half of the money originally intended for the Minidoka Project was transferred to the Payette-Boise Project, fueling disagreement between landowners and Reclamation. At the time, Reclamation offered the explanation that the Boise and Payette Valleys presented greater agricultural potential than the Minidoka region. The Boise region had established agriculture and irrigation systems, and a Reclamation project would augment established agricultural practices. By comparison, the Minidoka Project was attempting to create cultivated land from desert. The Secretary of the Interior, Ethan A. Hitchcock, authorized the Payette-Boise Project on December 27, 1905. Due to funding shortages Reclamation focused on developing the Boise Valley before the Payette Valley, and thereafter shortened the project name to Boise. Reclamation's Chief Engineer, F. H. Newell, advised district engineer Ross to choose a part of the project that could be independently developed. Ross and a committee consisting of the governor and state engineer of Idaho and Reclamation's regional engineers chose to construct a diversion dam on the Boise River and a storage reservoir at Deer Flat. After acquiring the necessary property, work began using a revised version of Ross's 1904 plans. The dam would direct water from the Boise River to Deer Flat by way of the New York Canal. At Deer Flat large earthen embankments would be constructed to create a reservoir. Engineers decided to use the New York Canal rather than the Ridenbaugh Canal, because the New York Canal was situated on higher ground and could irrigate 75,000 more acres than the Ridenbaugh. Also, the New York Canal and its headgates were already established at an ideal location "where the Boise River emerged from its rocky gorge" seven miles outside of Boise. Examination of historic photographs suggests that Reclamation replaced the existing wood canal headgates with concrete headgates, but utilized the same location. The Payette-Boise Water Users' Association also negotiated with the New York Canal Company to use the right-of-way and expand the canal without any charge to the federal government. This was fortunate as the water users' association had bogged down in negotiating the purchase of the Ridenbaugh Canal. The day after construction approval was granted, Reclamation advertised for bids on the project.[22]

Building a Dam

After settling land issues, including the organization of irrigation associations to pay for the dam's construction, bids were accepted in February of 1906. The Utah Fireproofing Company of Salt Lake City had submitted the lowest bid of $158,950 and began work in early March of that same year. The company had "done work of a similar character in a satisfactory manner" and had sufficient financial backing for the project. The contract called for a rubble-concrete masonry dam with concrete abutments and concrete canal headworks. Reclamation favored rubble-concrete weir designs for diversion dams. Two other diversion dams completed in 1908 were also rubble-concrete weirs: Granite Reef Diversion Dam on the Salt River Project in

[22] For further information on the Minidoka Project and its relationship to the Boise Project see Demian Hess and Jeffrey A. Hess, "Minidoka Dam, Powerplant, and Southside Pump Division," 2002, HAER Report No. ID-16, available at BOR Pacific Northwest Regional Office, Boise. Gardner, 16; Letter from Payette-Boise Project Board to F. H. Newell, February 15, 1905, Idaho State Historical Society, Boise; Letter to A. P. Davis from D. W. Ross, October 19, 1905, Idaho State Historical Society, Boise; Letter to the Secretary of the Interior, February 13, 1906, General Records, Washington, D. C., Entry 3, Box 407, RG 115, FRC Denver, 1; quote from Carlton, 78. See ID-17-A-34 for a view of the concrete headgates after they were completed.

Arizona and Leasburg Diversion Dam on the Rio Grande Project in New Mexico. Rubble concrete was also touted for its cost efficiency. It used less cement than rubble masonry yet presented similar structural benefits. The Boise structure would include an 8' wide wood and concrete fish ladder; a 30' wide rubble-concrete logway; and concrete diverting tunnels located at the base of a 60' wide reinforced-concrete wall between the logway and the canal headworks. Completion of the project was set for April 1, 1907. Bids were also submitted for work on other parts of the Boise Project, including construction work on the New York Canal, construction of a canal from Indian Creek to Deer Flat, and the construction of embankments to create the reservoir at Deer Flat, later named Lake Lowell.[23]

The contractors set up camp on the north side of the river, about a quarter mile downstream from the dam site. Historic photographs show a narrow campsite of less than a dozen, wood-frame, gable-roofed buildings and several canvas tents. The frame buildings likely housed the offices, shops, the mess hall, and the supervisors' quarters, while the laborers resided in the tents. Work on the diversion dam proceeded at a slow pace. Excavation went 10' below the riverbed to a 20' thick layer of basalt. A bed of compacted gravel was laid on top of the basalt. The two tunnels on the south side of the river were the first excavated so water could be diverted while work proceeded on the spillway portion of the dam. Then a cofferdam was built so work could begin on the dam's foundation at the north end. Once the diverting tunnels were finished, excavation and construction of the main body of the dam could proceed. Gravel from the excavation was used for concrete.[24]

Concrete formed the tunnels, the fish ladder, and part of the canal headworks. It was mixed in a plant with an electrified crusher and mixer located on the south side of the river. The remainder of the concrete was mixed in a plant using electrified and steam-driven crushers and an electrified mixer located on the north side of the dam. Gravel for that concrete was quarried from a pit on a side hill a quarter mile upstream from the concrete plant. Large rock for the masonry elements of the dam was taken from a vertical cliff on the north side of the river, about 80' to 100' above the dam. A temporary trestle was constructed over the river to transport ore cars carrying concrete from the plants to chutes connected to skips, which were then lifted by derricks. The main body of the dam rested on the compacted gravel foundation 10' below the riverbed and was composed of rubble concrete consisting large stones embedded into concrete. The dam's upstream and downstream faces were finished with rocks set 30" into a Portland cement mortar. By the end of June 1906, according to contract, 20 percent of the work was supposed to be finished. In reality only 3 percent had been completed.[25]

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[23] United States (U.S.), Department of the Interior, *Fifth Annual Report of the Reclamation Service* (Washington, 1906), 124, Plate 36; "Rubble Concrete Dam for the Atlanta Water & Electric Power Co.," *Engineering News* 52 (July 7, 1904), 15; Quivik and Slaton, 34-35; Carlton, 79.

[24] Available records do not indicate who worked at the site, how they got there, etc. U.S. Department of the Interior, *Ninth Annual Report of the Reclamation Service* (Washington, 1910), 109-111. See ID-17-A-54 and ID-17-A-55 for photographs of the construction camp.

[25] *Ninth Annual Report of the Reclamation Service*, 109-111; *Fifth Annual Report of the Reclamation Service*, 124. See ID-17-A-55 through ID-17-A-60, and ID-17-A-62 for photographs of the dam construction.

Reclamation's *Sixth Annual Report* cited poor management as the impediment to work on the dam. Delays could also be blamed on the weather and the river. The river level rose in January and February of 1907, an unusual occurrence. The river continued to flow at a greater volume than anticipated through June, delaying progress further. By the original completion date in April, only 41 percent was finished. A more efficient system developed as work progressed into late summer and autumn. A day shift of masons and their assistants laid the face courses of solid rock higher than the interior core of the dam. The night shift would then continue the work on the core using rock set aside by the day shift to fill the interior. This process required masons to spread a 6" to 12" layer of concrete, and then bed large rocks close together in the layer. Smaller stones were used to fill in any gaps. The completed layer was then covered with more concrete and the whole section was vibrated to fill in crevices. The following year the river again flooded, damaging the contractor's equipment and onsite plant. Still, the contractor accomplished most of the work after the spring flood had diminished. The trashrack protecting the sluicing tunnels was installed during this time. By June, approximately 90 percent of the project was done.[26]

When finally finished on October 10, 1908, the project was $89,360 over budget. The final piece was the installation of a timber-crib apron below the spillway to protect the dam's base from erosion. The apron was 216' long, 48' wide, and 13' deep below the streambed. It was composed of 12" x 12" timbers drift-bolted and fastened with rods and yokes to form cribs. These were filled with coarse gravel and covered with milled boards. A riprap apron 3' deep was also laid for 40' on the downstream side of the dam. The timber-crib apron was soon damaged during the 1909 irrigation season by logs passing over the spillway. Repairs were made during the autumn and winter months when the water level was low. The next few years served as a trial period. Portions of the dam were modified to increase efficiency and prevent damage to the structure. In the autumn of 1910, in an effort to prevent unwanted seepage, earth and gravel fill was added to the dam's upstream face to 7' below the crest. A log boom was added further upstream to direct timbers and other debris to the logway. The boom, formed of logs anchored to four large timber cribs and one concrete anchor-pier, was set at a 60-degree angle to the dam.[27]

Sometime during the 1909 irrigation season, the trashrack at the north diversion tunnel, which was being used for sluicing, had been crushed. Debris floated under the sluice gate, effectively blocking it. Following the irrigation season, the dam tender attempted to clear the obstruction using grab hooks. Even though debris and logs were removed, the gate still would not close. The next year similar attempts were made to clear out debris and close the gate. When these failed, a timber bulkhead was sunk in front of the north sluice tunnel to seal it temporarily. Before construction could proceed on an approved powerplant, the trashrack and sluice gate had to be repaired so the river could drain through the tunnels and allow new excavation and construction to proceed. In the fall of 1911, repairs on the damaged trashrack and sluice gate began. After

[26] *Ninth Annual Report*, 110; U.S. Department of the Interior, *Seventh Annual Report of the Reclamation Service* (Washington, 1908), 87.
[27] *Ninth Annual Report*, 110; U.S. Department of the Interior, *Eighth Annual Report of the Reclamation Service* (Washington, 1909), 78; Carlton, 82. See ID-17-A-34 through ID-17-A-36 for photographs of the completed dam.

building a quarter-round cofferdam in front of the tunnel, the work crew discovered that broken timbers and other debris from the trashrack were deposited on the concrete floor in front of the sluice tunnels. In addition, only a thin section of the top of the sluice gate survived. The rest had been washed downstream. All this made it difficult to secure the cofferdam to the concrete tunnel floor and the dam walls. A timber bulkhead was lowered and attached to the wall at the tunnel's downstream discharge opening. This sealed off the tunnel so the water could be pumped out. The cofferdam was successfully pumped dry on the second attempt and work rapidly proceeded on removing damaged material and replacing the gate and its guides. The job was completed in less than a month using round-the-clock shifts.[28]

Powering Arrowrock

The initial phase of the Boise Project, the construction of the diversion dam and the creation of Lake Lowell, was soon followed by plans to construct Arrowrock Dam and reservoir upriver from the diversion dam. This structure would lengthen the irrigation and growing seasons by storing spring runoff. In 1911, engineers realized the lengthy construction period anticipated for Arrowrock required an inexpensive power supply. Reclamation decided on electricity after cost estimates for purchasing, transporting, storing, and handling coal at Arrowrock were too high. There was ample water head at the Boise Diversion Dam, enough to provide for three separate waterpower rights below the dam and for a hydraulic powerplant at the dam, even during low water flow. A board of engineers composed of A. P. Davis, A. J. Wiley, W. H. Sanders, F. E. Weymouth, and C. H. Paul recommended construction of a 1500 kW three-generator powerhouse at the diversion dam as part of the Arrowrock Dam construction. The Department of the Interior approved the project in January 1911. Plans were drawn up at Reclamation's Los Angeles office by the chief electrical engineer, Orville H. Ensign. Ensign had worked his way from locomotive manufacturing to hydroelectric plant construction. He pioneered hydroelectric development in southern California in the 1890s with construction of the first three-phase powerplant in the United States and the world's longest transmission line carrying 33,000 volts eighty-two miles. In 1904 he joined Reclamation and designed several of Reclamation's early hydroelectric plants.[29]

Ensign initially protested the location of the powerplant on top of the dam. He preferred a location on the New York Canal downstream from the dam; however, his protests were overridden by Reclamation's regional board of engineers. The resulting design was similar to those of other early Reclamation powerplants. Early plants were modest in size and utilized every available inch of building area at the dam sites. Machinery was fairly standard for the

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[28] Paul, "Boise Power Plant," 12-15.

[29] Ensign was also in charge of electrical and mechanical engineering for the Los Angeles Railway from 1893 to 1896, and is credited with the design for an innovative needle valve used at early Reclamation dams. *Fourth Annual Report of the Reclamation Service,* 352; "Personal," *Journal of Electricity, Power, and Gas* 12 (May 1902): 100; Paul R. Secord, "Southern California Edison Company, Santa Ana River Hydroelectric System," 1985, National Register of Historic Places Inventory Nomination Form prepared for the Southern California Edison Company, available at the Office of Historic Preservation, California Department of Parks and Recreation, Sacramento, 8-5–8-6, 8-11.

period. Most turbines were vertically set, rather than horizontally, to conserve space, and the number of turbines and generators depended on the amount of power needed. Single generators typically ranged in power from 500 to 1200 kW. At the Boise Diversion Dam, the three-level layout for the powerhouse made the most of a limited area. Vertical turbines would be set in wheel pits occupying the lowest level of the plant. The middle floor would hold hydroelectric equipment on the upstream side and a machine shop on the downstream side of the building. The main level would house the generators, transformers, and switchboard. It would have a soaring 45' ceiling and single-hung sash windows to provide air circulation and machinery cooling. Reclamation would oversee construction of the building by an in-house crew from the Arrowrock Dam project upstream, while the manufacture of the hydroelectric equipment was bid out. Bids were awarded in May 1911 to the Allis-Chalmers Company for the turbines, governors, thrust bearings, and generators; to Westinghouse Electric and Manufacturing Company for the transformers; and to the General Electric Company for the switchboard and its appurtenances.[30]

Before beginning work on the powerplant, the crews had to wait for the spring flood to subside. To provide access to the powerplant site, the engineers decided to build a temporary trestle bridge on the crest of the dam that would connect the north bank and the railroad to the south bank and the powerplant site. Excavation was required for a new tailrace tunnel south of the two sluicing tunnels. These existing tunnels would also serve to carry tailraces from the turbines. While the work crew waited for the water level to drop, a transmission line was connected from the Barberton hydroelectric plant further downstream to the diversion dam and on to Arrowrock. The government agreed to rent power from the Idaho-Oregon Light and Power Company, operators of the Barberton plant, until the diversion dam powerplant was up and running. Workers also built an office, blacksmith shop, cement shed, and construction plant during this preparatory period. Accommodations at the site were divided into north and south camps. "Old Camp 1" was located half a mile downstream from the dam on the south side of the river. It contained the mess hall and several tents for the laborers. The north side camp held the office building and a bunkhouse for the timekeeper, construction superintendent, and principal foremen.[31]

Construction of the trestle and excavation for the powerplant began in early August 1911. Crews waited until the water level above the dam was lowered at the end of the irrigation season. Excavation for the tailrace tunnel and draft tubes had to occur during low water, while completion of the building's main level could occur during the irrigation season when water was diverted through the sluice tunnels. Because two sluicing tunnels were complete, the first excavation on the southernmost wheel pit, draft tube, and tailrace tunnel was started on the upstream, or east, side of the dam. The turbines were housed in the wheel pits; the draft tubes

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[30] O. H. Ensign, Letter to A. P. Davis, November 3, 1910, General Records, Washington, D.C., Entry 3, Box 389, RG 115, FRC Denver; "Hydroelectric Development of the Salt River Project," *Electrical Review and Western Technician* 59 (December 30, 1911): 1324-1327; "Nevada, Truckee-Carson Project," *Reclamation Record* 2 (November 1911): 273; Hess and Hess, "Minidoka Dam," 4-6; Gaylord, 1-2, 4, 8-9; Gardner, 34.
[31] Paul, "Boise Power Plant," 9, 23. See ID-17-A-61 for a photograph of the Old Camp 1.

carried water from the wheel pits to the tailrace tunnels which transported the water to downstream outlets. To insure the safety of the workers and the structural stability of the dam, the wheel pits were excavated and then concreted one at a time. The first wheel pit and draft tube were finished by mid-October. By December 6, 1911, all the concrete work was complete to the thrust-bearing floor level. That floor was finished by December 16, and the main floor was added by January 10, 1912.[32]

The cast-iron and steel butterfly gates to the wheel pit openings were put in place in preparation for the installation of the hydraulic and electrical machinery. By doing this, the machinery would be protected from any unexpected floods in early spring. The massive 9' x 12' steel gates were furnished by Fulton Engine Works of Los Angeles, assembled on site, and installed in January and February. The gates operated on center columns coupled to operating shafts that were linked to hand-operated worm gears on the main floor of the plant. One man could open a gate if water pressure was equalized by the filling, or bypass valve; otherwise the task required four men. At the end of January, the hydraulic and electrical machinery arrived and its installation began. A representative from the Allis-Chalmers Company oversaw and inspected all work with the machinery. The turbines and generators were in place by the end of March.[33]

Focus now shifted to completion of the building. While derricks lowered the turbines and generators into position on the upstream side, the west wall and the west halves of the north and south walls were completed to provide a protective shell for the equipment. Following the placement of the heavy machinery, the upstream wall and roof were constructed to enclose the powerhouse complex. The plant was officially tested between April 29 and May 2, 1912, with Reclamation and Allis-Chalmers personnel present. The trestle bridge was left up and the railroad track removed so the wood deck could accommodate pedestrian and vehicle traffic. The trestles were used to support flashboards, which could raise the height of the forebay pool and increase canal volume and power production. The existing camp buildings were removed from the north and south banks. Three new cottages were built on the north bank.[34] The Class B operator's cottage measured 28' square and cost $1,032 to construct and finish. The Class C and D cottages measured 18' x 26' and 18' x 52', and they cost $920 and $1,500 respectively to build. All the cottages were wired for electricity, had complete bathrooms and kitchens, and running hot and cold water. The plant was turned over to the operator, E. L. Casad, and his staff on May 12. It transmitted electricity fifteen miles upstream to Arrowrock through two sets of parallel lines spaced 50' apart. A total of 206 white cedar poles were used to support the lines

[32] Paul, "Boise Power Plant," 10-11. See ID-17-A-63 through ID-17-A-66 for photographs of construction of the powerplant.
[33] Paul, "Boise Power Plant," 11; Gaylord, 18-19.
[34] These cottages are now known as House No. 15, House No. 16, and Building No. 205.

from the powerplant to the substation at Arrowrock. These were hauled into position by teams composed of two or three men and a single horse. The entire project had been accomplished in less than a year.[35]

Innovation

In the year following the powerplant's construction, a new problem arose. Because the logway's crest was 4' lower than the dam's spillway, a large volume of water often flowed through the logway, creating the potential for erosion to the New York Canal bank retaining walls between the logway and the river. Also during low water periods, the river would flow over the logway before reaching the powerplant and canal, causing loss of head to both.[36]

Ideally, a movable gate would solve the problem by closing off the logway, yet opening when necessary to allow logs to pass through, or in case of a flood. Reclamation set about trying to design a cost-efficient solution. Its preferred design was a 60,000-pound Stoney gate that would cost approximately $11,000 to manufacture and set in position. Fortunately, Reclamation had also been in contact with a German company, Maschinen-Fabrik, Augsburg-Nurnburg, that held a patent on a "rolling dam." This innovative gate was purchased and installed at a cost $7,530.[37]

In preparation for the gate's arrival, thirty cubic yards of concrete were removed from the logway's south abutment and from the north pier separating the logway and spillway. The height of both the abutment and pier were raised to accommodate the rails that the gate would run on. A timber cofferdam was built to divert water away from the logway, and a timber falsework was also constructed to protect the work area from harsh winter weather. The preparatory work began in August 1912, the gate components arrived on January 3, 1913, and installation was finished by the end of February. Assembly and positioning of the gate were made simple by the detailed drawings and instructions provided by the manufacturer. Each equipment part was also clearly labeled. The foreman in charge was proficient in German, but a Reclamation technical report notes that his skill was unnecessary since the manufacturer's illustrations were so thorough.[38]

The major component of the gate was a large hollow cylinder, 2'-6" in diameter and formed of reinforced boiler plating. This cylinder acted as the shaft for the entire gate system. A sprocket chain connected the southern end of the shaft to the operating mechanism, which consisted of a sprocket wheel, a shaft, gears, and a 3 hp, 500 rpm motor. In case of motor failure the whole system could be operated by hand. A larger curved metal plate was secured to the main cylinder. This arced piece had a chord length of 8' and an arc radius of 6'. It formed the dam portion of the

[35] Paul, 4-5, 11-12, Final Cost Report, Sheets 2-3. See ID-17-A-67 and ID-17-A-68 for photographs of the new equipment after completion of the powerplant.

[36] Charles H. Paul, "Boise Project Storage Unit Feature Report: Rolling Dam," March 1913, General Records, Washington, D.C., Entry 10, Box 49, RG 115, FRC Denver, 1.

[37] A Stoney gate, for large openings, bears on a train of rollers in each guide, in comparison to a fixed-wheel gate, which has fixed wheels riding in guides. Paul, "Rolling Dam," 1-2; Charles H. Paul, "Rolling Dam of the Boise Project," *Engineering Record* 68 (August 2, 1913): 125.

[38] Paul, *Engineering Record*, 125-126; Paul, "Rolling Dam," 6.

gate. Gears, 7'-6" feet in diameter, were fastened to the ends of the main cylinder and engaged notched rails embedded into the north and south walls. The rails inclined at an angle of 21.5 degrees with the vertical. Oak timbers set into the concrete abutments and faced with flexible steel plates, acted as wedges when the gate was lowered. An oak sill spanned the entire crest of the logway and sealed off the bottom when the gate closed.[39]

Developing Southwestern Idaho

In 1911, Reclamation had sent a geologist, W. O. Crosby, to study two potential sites, Arrowrock and Hell Gate, for a large reservoir dam. Although both sites had positive and negative topographic features, Reclamation decided to go with Arrowrock, which would require less excavation than the Hell Gate site. The dam planned for Arrowrock was of the gravity-arch type. A gravity design would insure that a spring flood would not overrun the dam, while the hard rock canyon walls were ideal for construction of an arch dam, where the pressure against the upstream face of the dam is carried through the arch into the canyon walls on either side of the structure. Arrowrock would be one of the largest dams that Reclamation would build. The government would act as its own contractor in an attempt to prevent excess spending and delays in work.[40]

Excavation on Arrowrock Dam began in the spring of 1912, shortly after the powerplant at the diversion dam was completed. The dam was finished in November 1915, ahead of schedule. It measured 350' above bedrock with a base 223' thick and an upstream radius of more than 670'. It was the tallest dam in the world and its impact on southwestern Idaho was immediately felt. In 1916, 100,000 acres in the Boise Valley were irrigated, as compared to 45,575 acres in 1911, when work on the dam commenced. By 1919, 150,000 acres were under irrigation in the valley.[41]

In the 1920s, Reclamation returned to the Payette Valley. Previous to this period there had not been enough funding to address irrigation in the Payette River watershed. Projects in the newly formed Payette Division reflected Reclamation's shift from irrigation to power generation and flood control. With increasing populations in the western states, the erratic cycle of drought and flood became more perilous. Dams could provide a solution by reserving water for irrigation and suppressing floodwaters. The increased speed of water passing through a dam's outlet works also created potential for power development. Reclamation had used hydroelectricity on its earliest projects, but only for construction purposes. As the land around Reclamation projects was settled, the market for electricity dramatically increased. Irrigation associations were able to sell surplus electricity and reinvest the profits into the irrigation works. Reclamation also managed several of its hydroelectric plants and supplemented its budget with power revenues. Eventually hydroelectric development became as important a goal as irrigation. Reclamation rationalized this shift since immediate power revenues funded the construction of irrigation works, which

[39] Paul, "Rolling Dam," 2-4; Paul, *Engineering Record*, 125-126. See ID-17-A-69 and ID-17-A-70 for photographs of the rolling gate.
[40] Gardner, 18-20.
[41] Ibid., 27-28, 31-34, 36-40.

took decades to repay. The first Payette Division structure built was Black Canyon Diversion Dam, a 183' high concrete gravity dam with an adjoining hydroelectric plant. Reclamation next proposed construction of a 123' high concrete-arch dam with a constant radius of 275' at a site on the Deadwood River. Approval for the dam was secured by promising that the reservoir would be used primarily for power generation. By doing so, irrigation in the Payette Division was further postponed until 1948 when Cascade Dam, on the North Fork of the Payette River, was constructed. Measuring 107' in height and 785' long, Cascade Dam was formed of earth and rock fill. With its 650,000 acre-feet storage reservoir, it finally provided the water needed to develop the Payette Valley.[42]

In the Boise Valley, agricultural development outpaced the storage capacity of Arrowrock Dam by the late 1920s. Although the Idaho legislature and local boosters lobbied Congress for an additional storage dam upriver from Arrowrock, action was not taken until the early 1940s. Reclamation chose to build a dam on the South Fork of the Boise River, forty-two miles upstream from Arrowrock and twenty miles northeast of a town called Mountain Home. Anderson Ranch Dam would be an earth-fill structure impounding water for irrigation and also for power production. Work on the dam began in late 1941 and was delayed during World War II due to lack of men and materials. Finally completed in 1950, $16 million over budget, the dam impounded 423,000 acre-feet of water. Its 1,350' long crest was 456' above bedrock with a height of 330' above the riverbed. The base measured 2,650' in width and narrowed to 40' at the crest. The powerplant contained two generators able to produce 27,000 kW of electricity.[43]

In 1949, an additional structure was erected between Arrowrock Dam and the Boise Diversion Dam. Lucky Peak Dam was designed and built by the Army Corps of Engineers (COE) for flood control. A spring flood in 1943 damaged farms, bridges, and levees in the Boise Valley. Thanks to a diligent river watermaster, Boise and the surrounding communities were able to prepare for the flooding, and no lives were lost. However damage worth approximately $1 million was caused, two-thirds of which was agricultural. Even though Arrowrock Dam and Lake Lowell contained part of the floodwaters, Boise city leaders were convinced of the need for additional flood prevention structures. In 1936, Congress had declared flood control a national issue and charged the COE with a nationwide flood-control mission and budget. When southwestern Idaho turned to the COE in 1943, money and plans were readily available. When the COE presented plans for Lucky Peak Dam in early 1945, neither urban nor rural residents were convinced of the need for the dam and its expense. It was up to the COE and a booster group, called the Southwest Idaho Water Conservation Project, Incorporated, to convince the community that the dam could also expand irrigation into the desert south of the Boise Valley. Congress approved the dam, with its primary function being flood control. Irrigation was intended as a side benefit, but never came

[42] Clay Fraser and Jeffrey A. Hess, "Deadwood Dam," May 1991, HAER Report No. ID-18, available at BOR Pacific Northwest Regional Office, Boise, 4-6; Jay Brigham, "From Water to Water and Power: The Changing Charge of the Bureau of Reclamation," Bureau of Reclamation History Symposium, June 2002, Las Vegas, Nevada, 3-5; Gardner, 46.
[43] Carlton, 102-106.

about because the topography and the expense to build aqueducts and tunnels for water conveyance halted any efforts to use Lucky Peak's reservoir. Although Lucky Peak controlled the amount of water the diversion dam received, there were no adverse physical effects to the dam or powerplant.[44]

Maturity
After completion of the powerplant, no radical alterations were made to the site or its machinery. When Arrowrock Dam was finished, Reclamation contracted with Idaho Power Company to market the electricity generated by the plant. The plant operated at a constant rate throughout the irrigation season, but it was shut down for one to two months in the fall and winter to sluice built-up silt on the upstream side of the dam through to the downstream side. The old timber retaining wall protecting the lower bank of the New York Canal, at the outlet tunnels for the turbine tailraces, had shown signs of giving way, so in 1918 a crew was sent to the site from Reclamation's Boise office to make the repairs. It was replaced with a 50' long, reinforced concrete wall. [45]

Over the next twenty years, routine maintenance and repairs dominated work at the dam. The plant was operated during the irrigation season and as a backup for the Black Canyon Dam powerplant in the Payette Division. At the end of the irrigation season, the generators and turbines were cleaned, and smaller machinery was checked and repaired. In 1928, a new timber boom was installed using the existing timber cribs and concrete pier. The buildup of silt and sediment on the upstream side of the dam became a serious problem. Placer mining at Idaho City caused an increase of silt in Mores Creek, which emptied into the Boise River upstream from the dam. The river current scoured the riverbed in the forebay pool above the dam and battered the concrete sluice tunnels with silt and sediment. Extensive dragging was done in the winter of 1932 to repair the eroded riverbed above the dam. A total of 890 yards of stone, gravel, and silt were used to fill another hole 20' upstream from the dam. Water had begun to leak underneath the dam to the downstream side, and investigation found that more water was flowing underneath the floor between the trashrack and the sluice gates. Following the irrigation season, new concrete was poured to fill in cracks and hollows at the upstream entrance of the sluice tunnels, and inside the tunnels where sections of the concrete floor were completely washed away. Like other Reclamation sites, the diversion dam also benefited from work performed by the Civilian Conservation Corps (CCC). The workers built rock and riprap walls along the river banks, added fill at the dam's north abutment, built fences around the dam tender's house, and constructed a concrete-pier flashboard system and new timber bridge on the crest of the dam.[46]

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[44] Susan M. Stacy, *When the River Rises: Flood Control on the Boise River 1943-1985* (Boise: College of Social Science and Public Affairs, Boise State University, 1993), 10-16, 29-39.
[45] US Department of the Interior, "Annual Project History of Boise Project, Idaho, for 1917," 132-133; US Department of the Interior, "Annual Project History of Boise Project, Idaho, for 1918," 76, 150-151; both are available at BOR Pacific Northwest Regional Office, Boise.
[46] U.S. Department of the Interior, "Annual Project History, Boise Project-Idaho, 1927," 62-63, 66; U.S. Department of the Interior, "Annual Project History, Boise Project-Idaho, 1928," 82; U.S. Department of the Interior, "Annual Project History and Operation and Maintenance Report, Boise Project-Idaho, 1932," 50-52; U.S. Department of the

Throughout the 1940s and 1950s, regular maintenance was performed on the machinery and structures. The plant operated during the irrigation season generating power for pumping stations spread throughout the Boise Project. Gradually machinery needed replacement or heavy repair work. The vanes on the lower runners of the turbines were cracking at the shroud-band joints but were easily repaired by welding. New bronze plating was added to the exterior edges of the sluice gates in an attempt to improve the gates' seals. The New York Canal headgates were reinforced with steel bands bolted to the upstream face of each gate to disperse stress across the entire gate. One of the stems at the headgates needed replacing after a log caught under a gate as it was closing and bent the stem. The gates were modernized in 1963 when they were wired to a switchboard and operated by pushbuttons.[47]

In 1962, the downstream face of the dam was sandblasted and repaired with new mortar around the existing rubble masonry. The bridge was also rebuilt and a concrete driveway was poured at the north approach to the dam. In 1964, an inspection team discovered that the surge tunnel, perpendicular to the tailrace tunnels, was in poor condition. The tunnel had deteriorated at the junctions with the tailrace tunnels and was in particularly bad shape from the northern tailrace to the discharge point at the logway. In addition, the concrete floors in the sluice tunnels had to be repaired every few years. In the late 1960s, the log boom was removed and the timber cribs dismantled. The downstream face was again repointed and a 10' wide strip of riprap was added to the downstream apron.[48]

Management of the dam tender's house and the other camp buildings was transferred to the Boise Project Control Board (Control Board) in 1926 along with other Boise Valley irrigation-related properties. The property was still federally owned, but its maintenance was under the Control Board's jurisdiction. All of the houses at the camp were extensively remodeled and "improved" in 1930, and again in the 1950s and 1960s. House No. 15, the dam tender's house, and Building No. 205, the garage and office, received the most attention and were in constant use. House No. 16 was used occasionally for staff quarters. Alterations included rewiring the buildings, installing sheetrock on interior walls and ceilings, installing asbestos-cement shakes and shingles on exterior walls, and modernizing kitchen and bathroom fixtures. In 1959, House No. 17 was converted into a three-car garage, storeroom, and bachelor's quarters. Three

Interior, "Boise Project History, 1936," 32; U.S. Department of the Interior, "Boise Project History, 1937," 53-56; all are available at BOR Pacific Northwest Regional Office, Boise.

[47] U.S. Department of the Interior, "Boise Project History, 1956," 55-56; U.S. Department of the Interior, "Boise Project History, 1958," 44; U.S. Department of the Interior, "Boise Project History, 1959," 54-55; U.S. Department of the Interior, "Boise Project History, 1963," 66; all are available at BOR Pacific Northwest Regional Office, Boise. See ID-17-A-71 and ID-17-A-72 for photographs of the dam and powerplant in the 1950s.

[48] "Boise Project History, 1962," 80-82; U.S. Department of the Interior, "Boise Project History, 1964," 91-92; U.S. Department of the Interior, "Boise Project History, 1966," 75; all are available at BOR Pacific Northwest Regional Office, Boise.

overhead garage doors were installed on the north wall. The living quarters were retained, but were compacted into the east end of the building. These eventually became office space for the dam tender. The building's name also changed to Building No. 205.[49]

The dam tender's house and the garage/office were jacked up and shimmed in the 1960s to repair rotted floor joists. A smaller garage west of House No. 15 was torn down in 1960. A carport was built in the same location and is still in use today. In 1968, a porch and bedroom on the west facade were removed. New footings and a foundation were poured, and two larger rooms were constructed to replace those removed. The new addition has a gable roof. The shed additions to the east and north walls are not recorded in the histories. Neither is the application of stucco to the exterior faces.[50]

In 1965, a concrete foundation was laid immediately west of Building No. 205, and Building No. 203, a metal-framed storage shed, was moved to the site from the Central Snake Project Regional Office in Boise. Early in 1966, electricity was extended to the building, and the structure was painted to "blend" with the color of the other camp buildings.[51]

For the last thirty years, there has been very little change at the dam. On March 15, 1976, the site was listed on the National Register of Historic Places. The powerplant was operated sporadically during the energy crisis of the 1970s and early 1980s. In 1982 it ceased operation and was put on reserve status. Regular repairs to the concrete floors and walls of the sluice tunnels continued. In 1988, the upstream face of the powerplant was rehabilitated. The concrete was chipped away and new concrete, mixed to match the color and texture of the historic concrete, was formed up. Damaged sections of the building's cornices were also repaired at that time.[52]

As the West continues to suffer from an energy shortage, the decision was made to put the Boise Diversion Dam powerplant back online. While the dam has continually diverted water for irrigation and the powerhouse has been maintained, the hydroelectric equipment is outdated. Reclamation announced plans in 2000 to rehabilitate the powerplant's machinery so it can be

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[49] U.S. Department of the Interior, "Annual Project History, Boise Project-Idaho, 1930," 82; "Boise Project History, 1958," 45; both are available at BOR Pacific Northwest Regional Office, Boise; Paul Deveau, interview by author, October 3, 2002; Ray Leicht, interview by author, October 3, 2002,

[50] U.S. Department of the Interior, "Boise Project History, 1960," 8-9; U.S. Department of the Interior, "Boise Project History, 1961," 54-55; "Boise Project History, 1962," 82-83; "Boise Project History, 1963," 67; "Boise Project History, 1964," 169-170; U.S. Department of the Interior, "Boise Project History, 1965," 158; "Boise Project History, 1966," 75-76; U.S. Department of the Interior, "Boise Project History, 1968," 179-181; all are available at BOR Pacific Northwest Project Office, Boise.

[51] "Boise Project History, 1965," 158.

[52] U.S. Department of the Interior, "Annual Project History, Boise Project, Idaho, 1974," available at BOR Pacific Northwest Office, Boise, 123; U.S. Department of the Interior, *Historical Site: Boise Diversion Dam*, available at Boise Public Library, n. p.; U.S. Department of the Interior, Safety Evaluation of Existing Dams Program, "Examination Report of Boise River Diversion Dam," June 30, 1986, available at BOR Pacific Northwest Office, Boise, 2, 7; John W. Keys, III, Regional Director, BOR Pacific Northwest Regional Office, Boise, Letter to Robert Fink, July 27, 1988, n. p., available at BOR Pacific Northwest Office, Boise.

used to meet twenty-first-century power needs. The hydroelectric equipment at the Boise Diversion Dam is noteworthy because it is in original condition and exemplifies standard machinery and powerplant engineering from the early twentieth century. This report was produced to document the machinery before it is permanently changed. As part of the alterations to rehabilitate the powerplant, the three original generators will be replaced with new generators. The original generator frames, stators, excitation equipment, and walkway will remain unaltered. The original generator rotors and original generator belts will be removed to provide clearance for the new generators located on the floor below. The appearance of the slate control panels and regulators will be maintained, but the equipment will not be utilized. The concrete wings of the circuit breaker gallery will be removed and only one circuit breaker bay will be retained. One of the transformer cooling fans will be maintained but in an inoperative capacity. The hoist drive shaft of the original hand-operated crane will be modified to center the crane hoist over the egress hatch. A new governor will be placed in the lower level with the turbines, and although the historic governors will no longer function, they will be retained for historic context. A servomotor will be located in the thrust-bearing gallery, the wood generator bearings will be replaced, and the concealed turbine components will be rebuilt. New skin plates will be installed on the butterfly gates, and the bearings and bronze sealing surfaces will be refurbished. Electric motors to operate the gates will be added to the upstream side of the main floor. The existing metal trashrack will be replaced with a polyethylene version that is designed with curved slats on its upstream face, allowing water to pass more quickly through the trashrack. The new trashrack also has 1.5" wide spaces as compared to the existing 0.75" gaps that restrict water flow. The generator circuit breakers, instrument transformers, surge protection and ground transformers will be moved to the lower level next to the machine shop, which will be left alone. A 2500 kv-a power transformer will be added to the concrete slab on the exterior downstream side of the plant. Lightning arresters, line instrument transformers, and line circuit breakers will also be placed in this area.

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